Physicochemical and bacteriological characterization of raw sewage from the Meknes region Morocco

Ouallal *Hassan* [1, 4]*, El Hamzaoui *Najia*[2], Sbiti *Mohammed*[3], Machkor *Mohammed*[4], Messaoudi Lahcen4, Azrour *Mohamed*[1].

[1]Moulay Ismaïl University, Faculty of Sciences and Techniques, Departement of Chemistry fundamental and applied, laboratory of physic-chemistry Materiqls, PO Bosc 509 Irrachidia, Morocco
[2]Medical microbiology laboratory, Mohamed V Hospital, Meknes, Morocco
[3]Laboratory of bacteriology, Moulay Ismail Military Hospital Meknes Morocco.
[4]Moulay Ismaïl University, Faculty of Sciences, Département of Chemistry,Materials, Membranes and Processes of Separation, PO Bosc 11201, Zitoune, Meknes, Morocco

Abstract. The region of Meknes suffers from a significant delay in the water sector, including sewage treatment. The Urban waste water in the region originates from various activities; households, industry, agriculture and hospital. These waters are released in to nature without any treatment, which constitutes a serious risk for the environment. The objective of this research is to characterize the physicochemical and bacteriological pollution of the three sewage collectors of the Meknes region (Aïn Choubbik, Oued Ouislane and Aïn Taoujdate). Indeed, the pollution parameters; biological and chemical oxygen demand are abnormally high, which indicates clearly that waste waters is rich of reducing or oxidizing organic materials. Ammonium, nitrogen, phosphorus and heavy metals concentrations exceed the limit values. So these waters are classified as bad or very bad quality. On the one hand, the presence of a large bacterial load indicates fecal contamination. The total coliform, fecal coliform and fecal streptococci levels are high exceeding exceed the values specified the WHO guidelines and the Moroccan standards. This situation is likely to cause serious and irreparable damage to the environment groundwater. To counter this, make the necessary investment in sewage treatment and other remedial measures is key to preventing pollution and its spread.

Keyword: waste, water, bacteriological, physicochemical,

* Corresponding author: hassanouallalaghbalou@gmail.com

1. Introduction

In Morocco, water scarcity, waste and pollution are increasingly becoming a concern. Indeed, population growth and droughts since the 1970s are affecting water availability. The gap between the needs and availability of water increase might increase the size with the increasing of water-consuming sectors of all water-consuming sectors of the country. In order to address this situation, promoting the re-use of treated wastewater in agriculture becomes essential. It's is a very useful and very ancient practice across the globe [1]. At present, there is an area of about 7000 hectares directly irrigated with raw wastewater discharged by towns (about 70 million m^3 / year) with no precautionary measures. Meknes Region is the largest surface of wastewater irrigated crops. It is estimated about 1400 ha. It generally corresponds to it is of the order of 1400 ha and it concerns the cereals, the market gardens and the arboriculture [2]. The waste water reuse in agriculture constitutes a potential risk to human health and the environment. This study aims to evaluate the physicochemical and bacteriological parameters of the three sewage collectors of the Meknes region (Aïn Choubbik, Oued Ouislane and Aïn Taoujdate).This is intended to demonstrate the need for the treatment of waste water before being used in agriculture.

2. Materials and Methods

2.1. Sampling sites and sampling method

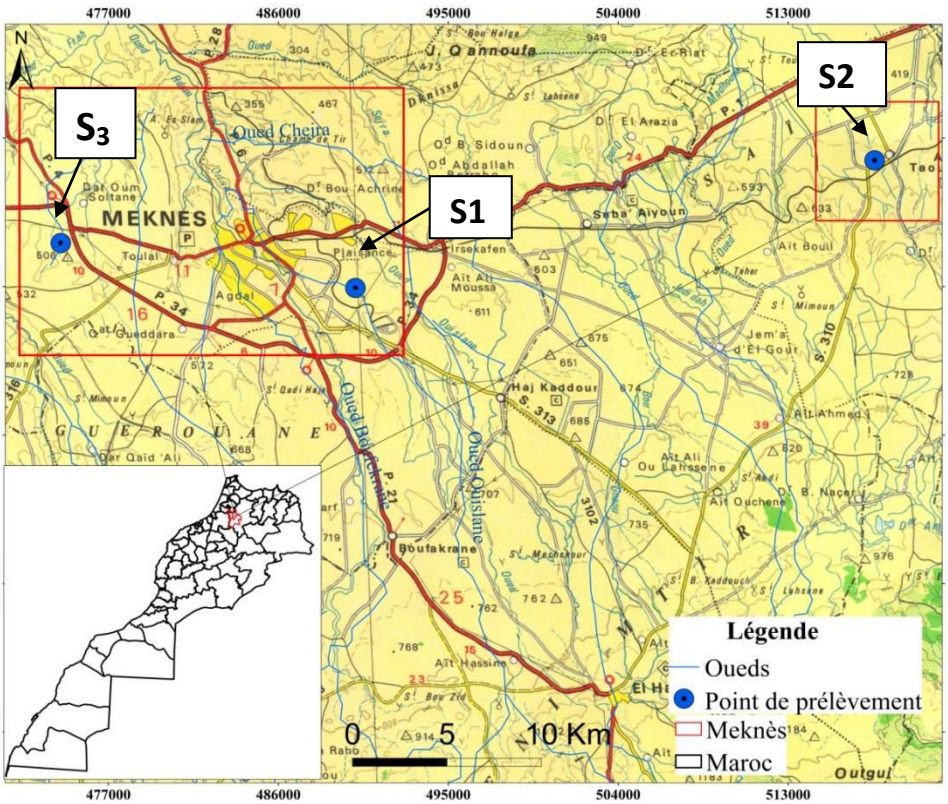

Fig1. Map of sampling points

The choice of sampling sites is based on their environmental features and on their use in agriculture.

The selected sites are;
Site (S1): Oued Ouislane belongs to the superficial hydrographic network of the region of Meknes, originates at the south-east of the village of Boufekrane. The sewage of Oued Ouislane is reused by the farmers.
Site (S2): Aïn Taoujdate is known for its agricultural and industrial activities (30 Km from Meknes). The residual urban water includes the flow from the households, industry, and discharges from the municipal slaughterhouse. This wastewater is reused for agriculture.
Site (S3): Aïn Choubbiik is the sanitation network, it receives the effluent from the Mohamed V hospital without treatment, and this wastewater will be directed towards Oued Bourouh located downstream. This water is reused in agriculture and for livestock watering.
Sampling is done in the morning between 10am and 1pm (time of rejects) in the summer 2017. Glass vials with screw caps are used and they are sterilized beforehand in the laboratory according to the protocol mentioned in Table 1.
Few drops of sodium thiosulphate are added to vials for bacteriological analysis sampling, they are added in the vials before sterilization to destroy the chlorine which may exert its action on the bacteria during transport. Some physico-chemical parameters as temperature and pH are measured in situ.

Table1. Sampling Protocol

Analysis	Amount
Physico-chemical	1 liter
Bactériological	250 ml sterile
Bactériological: search for salmonella	5 liter sterile

2.2. Methods of analysis of the different samples

All physicochemical and bacteriological analysis is made according to the techniques recommended by Rodier [3 and 4]: Tables 2 and 3

Table2. Methodology of physicochemical parameters

Parametres	**Méthodes d'analyses**
Temperature	Mercury thermometer
Conductivity	Conductivity meter of the type (meaning ion^{TM}EC71, HACH)
pH	pH-mètre
Oxygène dissous	Winkler
Nitrates	Molecular absorption spectrometry
Nitrites	Molecular absorption spectrometry
Sulfates	Nephelometric
Chlorures	Mohr

Table 3. Bacteriological analysis protocol

Germs	Volume	Culture media	Incubation	Techniques
Total coliforms	100 ml	TTC and Tergitol lactose agar	37 ° C during 24 hours	0.45µm filter membrane filtration technique
Fecal coliforms	100 ml	TTC and Tergitol lactose agar	44 ° C for 18 to 24 hours	0.45µm filter membrane filtration technique
Fecal streptococci	100 ml	Slanetz-Bartley	37 ° C / 48 hours	0.45µm filter membrane filtration technique
Total germs	1ml	PCA	37 ° C / 48 hours	Incorporation en gélose
staphylococci	100 ml	Chapman	37 ° C / 24-48 hours	0.45µm filter membrane filtration technique
Pseudomonas	100 ml	Cetrimide agar	42°C / 24hours	0.45µm filter membrane filtration technique
salmonella	5 Litres	sodium selenite then selective medium	Incubate 24h at 42 ° C then 24 hours at 37 ° C	Pre-enrichment during 24 hours then seeding and incubation

3. Results and discussion

3.1. Physicochemical characterization of analyzed waters

The results of physicochemical characterization of raw sewage in the region of Meknes are summarized in Table 4.

Table4. Results of physicochemical characterization of raw waste water from the studied sites during the period of April-August 2017.

Sites / Parametres	S1	S2	S3
Temperature °C	19,43	21	21
pH	8,72	9,23	7,67
DBO5 (mg O_2/l)	625	700	425
DCO (mg O_2/l)	1210	1530	970
conductivity (µs/cm)	1745	1895	1810
NH^{4+} (mg N/l)	66,8	74,3	66.7
Orthophosphate (mg P/l)	20,5	32,4	35.1
Chlorure (mg /l)	175,4	175,7	131.5
Sulfate (mg /l)	64,5	100,1	56.7
Cu (µg/l)	18,7	19,2	12.8
Cr (µg/l)	35,9	69,8	29.7
Cd (µg/l)	0,48	0,37	0.25
Fe (µg/l)	178	200,5	129
Mn (µg/l)	35	55	27
Mg (µg/l)	47	46	24
Pb (µg/l)	5,8	9,2	5.1
Zn (µg/l)	212	245	149
Ni (µg/l)	0	0	0
dissolved oxygen (mg /l)	4,5	0.23	0,97

3.1.1. Température

The average temperature of raw sewage in the region of Meknes is between 19.43 - 21 ° C. The temperatures recorded are included in the range of the direct discharge limit values in the receiving environment [5] and in the range of Moroccan standards for water quality for irrigation [6].

3.1.2.pH

The pH values of the raw sewage show that these waters are slightly alkaline and fall within the range of Moroccan standards for water quality for irrigation [6] and within the range of direct discharge limits [5].

3.1.3. Electrical conductivity

The values of the conductivity recorded at the level of the raw wastewater of the different sites vary between 1745- 1895µs / cm. This reflects an important mineralization (waters rich in salts and minerals). Electrical conductivity indicates the degree of overall mineralization; it provides information on the level of salinity. The electrical conductivity values meet the international regulatory standards for direct discharges and for irrigation of the crops [5, 6].

3.1.4. The chemical oxygen demand COD

Chemical Oxygen Demand is an important water quality parameter because, it provides an index to assess the effect discharged wastewater will have on the receiving environment. Higher COD levels mean a greater amount of oxidizable organic material in the sample, which will reduce dissolved oxygen (DO) levels[7].The average values recorded in the sites are very high (Table 4) and exceed the limit values of direct discharges [5], therefore, these waters are of very poor quality.

3.1.5. Biological oxygen demand DBO5

The BOD (Biochemical Oxygen Demand) is a measurement that aims to give the amount of organic material that can be broken down by micro-organisms. It is a widely-used parameter, which can be applied to all water types, especially sewage and purification processes [7].The average BOD5 concentrations of the three study sites ranges from 425 mg O_2 / L, 700 mg O_2 / L in urban waters of Ain Shubbiik and Ain Taoujdate respectively, these values are greater than limit values for direct discharges (100 mg O_2 / l) [5], therefore, these waters are of very poor quality.

3.1.6. Ratio DCO/DBO5

The COD / BOD5 ratio provides a deduction of the origin of wastewater pollution. In fact, a low value of the COD / BOD5 ratio indicates the presence of a large proportion of biodegradable materials and a biological treatment is envisaged. Inversely, a high value of this ratio indicates that a large part of the organic matter is not biodegradable therefore, physicochemical treatment is envisaged.
The average values of the ratio COD / BOD5 are 1.9, 2.18, and 2.28 in the waters of Oued ouislane, Ain Taoujdate and Aïn choubiik respectively. Therefore, it can be concluded that the wastewater in our study is easily biodegradable In spite of its high organic load. In addition, the values of the ratios are significantly lower than 2.5. On this basis, it can be concluded the dominance of domestic-type effluents [8].

3.1.7. Orthophosphate

The concentrations of orthophostate in the studied waste water are 20.5, 32.5 and 35.1 mgP /l for Oued Ouislane, Ain Taoujdate and Aïn choubiik respectively. These high values could be explained by wastewater discharges [8, 9].

3.1.8. Nitrogen

The concentrations of ammonium are high at different sites. A high level of nitrogen in the ammonium form is not toxic, but in alkaline waters (pH greater than 7.5), as was the case in our water analysis, a fraction could be transformed into ammonia form (ammonia gas) which is toxic.

3.1.8. Sulphate

Sulphate concentrations meet the limits values of direct discharges of wastewater and the ones of crop irrigation [5, 6].

3.1.9. Heavy metals (Cu, Cr, Fe, Mg, Mn, Pb, Zn, Ni)

Analysis of heavy metals have shown the presence of Cu, Cr, Fe, Mg, Mn, P and Zn with lower concentrations which meet the required limits values. These results were significantly different from those obtained from the sewage analysis of the Region of Oujda [10].

3.2. Bacteriological analyses

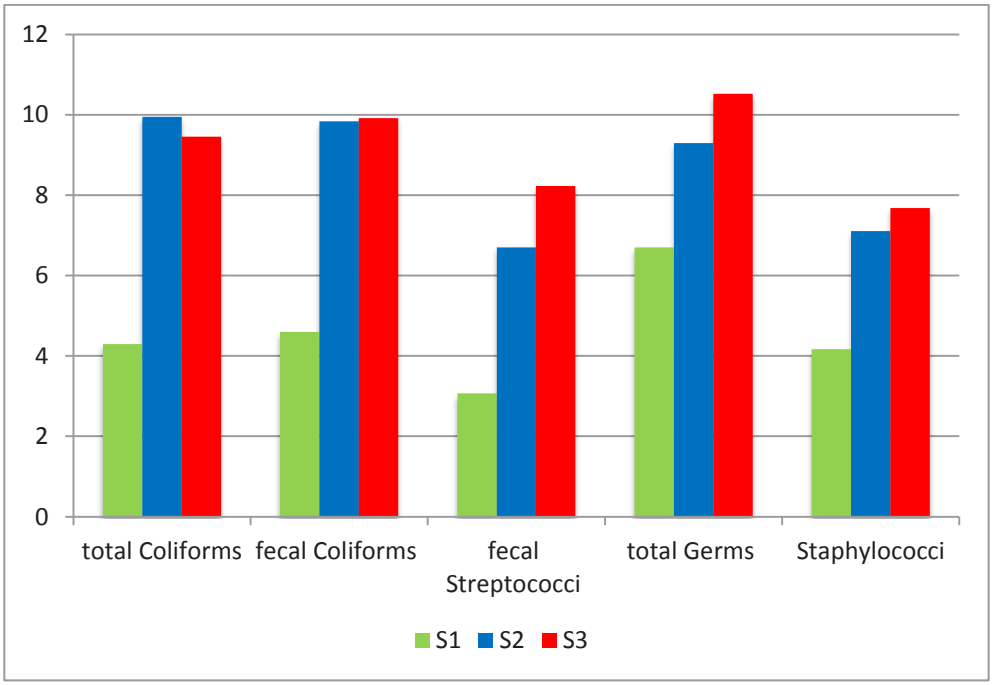

Fig2. Results of the bacteriological analysis of the three sites

Bacteriological analyses of different sites indicate the presence of germs that are indicators of fecal contamination (Figure 2). Some pathogenic germs are also present.

The average loads of total coliform (TC) are 1, 910^4; 2, 910^9 and 910^9 germs / 100ml for Oued Ouislane, Ain Taoujdate, and for Aïn Choubbik respectively. This shows direct contamination by the fecal matter. On the other hand, the average values of fecal coliforms are 1, 210^3; 710^6 and 8, 410^9 germs / 100 ml for oued ouislane, Aïn Choubbik and for Aïn Taoujdate respectively. Those values exceed the limit values recommended by the WHO [13].The high levels of fecal coliforms are attributable to the high content of organic matter (BOD5) and the lack of precipitation.

Results of the Oued Ouislane have been compared over the years [11] and allowed to conclude that the bacteriological quality has been deteriorating over the years. On, makes it possible to conclude that of the water has deteriorated over the years. The magnitude of fecal bacterial contamination of rivers, especially during the summer months, may be an imminent health risk [11].

The average value of the *fecal streptococci* (SF) are 1, 710^8; 510^6; and 1, 210^3 of Ain taoudjdate, Aïn Choubbik, Ouislane respectively.

Aïn choubbik site receives hospital Mohamed V effluents, which explains that Pseudomonas *aeruginosa*, were found only in this site. These waters are used without treatment in the irrigation, which constitutes health risk for major consumers.

The pathogenic germs such as genus *Salmonella* have been systematically sought for the three sites. None of the sites contained *Salmonella* bacteria. These results are consistent with previous study done on oued Ouislane [1, 12].

4. Conclusion

The physicochemical analysis of wastewater in the Meknes region has showed that these waters have a COD / BOD5 ratio less than 2.5, which indicates clearly that they are biodegradable. On the other hand, the analysis reveals the presence of heavy metals.
However, microbiological analysis revealed very high concentrations of germs in these waters, which constitutes a health risk. To address this issue, Wastewaters must, before being discharged into a natural receiving body, be treated. (The wastewater collected must flows through a number of preliminary treatment installations) (Case of Oued Ouislane and Mohamed V Hospital effluents).
To sum up, the studied wastewater should not be reused directly in agriculture or other activities as is no the case
To protect health or environmental quality, adequate treatment of wastewater discharges must be considered before any use. The quality of treated wastewater released must meet established standards.

References

1- CHAHLAOUI A. (1996). Etude hydro biologique de l'oued Boufekrane (Meknès), Impact sur l'environnement et la santé. Thèse d'état. Fac. Meknès. 234 p.
2- M. Bzioui : Rapport national sur les ressources en eau au Maroc.U.N. Water-Africa, 44p, 2004
3- Rodier, J., Bazin, C., Broutin, J.P., Chambon, P., Champsaur, H. et Rodi, L. 1996. L'analyse de l'eau. Eaux naturelles, eaux résiduaires, eaux de mer. Dunod, 8ème édition, Paris, pp. 1384
4- J. Rodier : L'analyse de l'eau. Dunod (Ed), 8ème Ed, 1384 p, 1996. B. Miller, Proc. 6 th Australian Electrochem. Conf., Geelong, Vic., 19-24 Feb., 1984; J. Electroanal. Chem., 168 (1984) 91
5- Valeurs limites des rejets directs et indirects du Maroc.
6- Ministère de l'Environnement du Maroc « Normes marocaines, Bulletin officiel du Maroc », N° 5062 du 30 ramadan.
7- Ouazzani N, Bousseltaj K & Abbas Y (1996) Reuse of waste water treated by infiltration percolation. WastSci Tech 33 (10/11): 401-408
8- Bechac JP, Boutin P, Mercier B & Nuer P. Traitement des eaux usées, Ed. Eyrolles, (Paris). 280 p.1987
9- NEAL C., JARVIE H. P., HOWARTH S. M., WHITEHEAD P. G., WILLIAMS R. J., NEAL M., HARROW M., WICKHAM H. The water quality of the River Kennet: initial observations on a lowland chalk stream impacted by sewage inputs and phosphorus remediation. Sci. Total Environ. 251-252: 477-495. 2000.
10- Aboueloufa M., El Halouani H., Kharboua M. &Berrichi A. Caractérisation physicochimique et bactériologique des eaux usées brutes de la ville d'Oujda : canal principal et oued Bounaîm. Actes Inst. Agronom. &Vet., Rabat, 22, 3, 143-150, 2002.
11- OMS (1989) Utilisation des eaux usées en agriculture et en aquaculture. Série de rapport technique 778

12- El Ouali Lalami1, A. Zanibou, K. Bekhti, F. Zerrouq, M. Merzouki. Contrôle de la qualité microbiologique des eaux usées domestiques et industrielles de la ville de Fès au Maroc. JMESCN J. Mater. 5 : 2325-2332.2014.